PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:
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PCT

NOTIFICATION OF TRANSMITTAL OF
INTERNATIONAL PRELIMINARY
REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

(PCT Rule 71.1)

Date of mailing (*day/month/year*)	02 APR 2007

Applicant's or agent's file reference	IMPORTANT NOTIFICATION
27840	

International application No.	International filing date (*day/month/year*)	Priority date (*day/month/year*)
PCT/IL04/00641	15 July 2004 (15.07.2004)	24 July 2003 (24.07.2003)

Applicant

DUNE MEDICAL DEVICES LTD.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary report on patentability and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary report on patentability. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the *PCT Applicant's Guide*.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed invention is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the IPEA/ US	Authorized officer
Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450	John F. Ramirez
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Form PCT/IPEA/416 (January 2004)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 27840	FOR FURTHER ACTION	See Form PCT/IPEA/416
International application No. PCT/IL04/00641	International filing date *(day/month/year)* 15 July 2004 (15.07.2004)	Priority date *(day/month/year)* 24 July 2003 (24.07.2003)

International Patent Classification (IPC) or national classification and IPC

IPC: **A61B 5/05**(2006.01);**G01V 3/00**(2006.01)
USPC: 600/411,547;324/309

Applicant

DUNE MEDICAL DEVICES LTD.

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 7 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *(sent to the applicant and to the International Bureau)* a total of 14 sheets, as follows:
      ☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) _____ , containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:
   - ☒ Box No. I Basis of the report
   - ☐ Box No. II Priority
   - ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - ☐ Box No. IV Lack of unity of invention
   - ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - ☐ Box No. VI Certain documents cited
   - ☒ Box No. VII Certain defects in the international application
   - ☒ Box No. VIII Certain observations on the international application

Date of submission of the demand	Date of completion of this report
11 January 2005 (11.01.2005)	05 March 2007 (05.03.2007)
Name and mailing address of the IPEA/ US Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer John F. Ramirez Sharon V Breese for Telephone No. (571) 272-8685

Form PCT/IPEA/409 (cover sheet)(April 2005)

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/IL04/00641

Box No. I Basis of the report

1. With regard to the **language**, this report is based on:

☐ the international application in the language in which it was filed.

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of:

☐ international search (under Rules 12.3 and 23.1(b))

☐ publication of the international application (under Rule 12.4(a))

☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

☐ the international application as originally filed/furnished

☒ the description:
pages 1-40 as originally filed/furnished
pages* NONE received by this Authority on _____
pages* NONE received by this Authority on _____

☒ the claims:
pages NONE as originally filed/furnished
pages* NONE as amended (together with any statement) under Article 19
pages* 41-54 received by this Authority on 22 September 2005 (22.09.2005)
pages* NONE received by this Authority on _____

☒ the drawings:
pages 1/15-15/15 as originally filed/furnished
pages* NONE received by this Authority on _____
pages* NONE received by this Authority on _____

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, sheets/figs _____
☐ the sequence listing (*specify*): _____
☐ any table(s) related to the sequence listing (*specify*): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, sheets/figs _____
☐ the sequence listing (*specify*): _____
☐ any table(s) related to the sequence listing (*specify*): _____

** If item 4 applies, some or all of those sheets may be marked "superseded."*

Box No. V **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims 2,4-10,12-15,17,19-38, and 47	YES
	Claims 1,3,11,16, and 18	NO
Inventive Step (IS)	Claims 5, 6, 10, 12, 14, 20-28, 32-35, and 47	YES
	Claims 1-4, 7-9, 11, 13, 15-19, 29-31, and 36-38	NO
Industrial Applicability (IA)	Claims 1-38, and 47	YES
	Claims NONE	NO

2. Citations and Explanations (Rule 70.7)
Please See Continuation Sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

Claims 39-46, and 48-71 are objected to under PCT Rule 66.2(a)(iii) as containing the following defect(s) in the form or contents thereof:
Claims 39-46 and 48-71 are improper multiple dependent claims which does not refer back to a preceding claim in the alternative only, they are dependent upon a prior multiple dependent claim.

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claims 30-34 are objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 6 because Claims 30-34 are indefinite for the following reason(s): there is no antecedent basis for the term "said transmission line."

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**

Continuation of:

V. 2. Citations and Explanations:

Claims 1, 3, 11, 16, 18, 41, and 43 lack novelty under PCT Article 33(2) as being anticipated by Eyuboglu et al. (U.S. 6,397,095).

Eyuboglu et al. teaches a method of examining a substance volume to characterize its type, including applying a magnetic field and RF pulses to the volume to produce electrical impedance and magnetic resonance response signals, detecting those signals, using the detected signals to characterize the type of substance examined, where the electrical impedance signals are used to determine the effective electrical impedance of the volume and where the magnetic resonance signals are nuclear magnetic resonance signals, and an apparatus for implementing that method, including means for applying a magnetic field through the volume, a probe, which includes a current sensor for sensing the current passing through the volume, and an electrical control and processing system, which includes an indication of the type of substance volume examined (col. 1, lines 25-30 and 39-46, col. 2, lines 13-17 and 61-67, col. 3, lines 1-6, col. 4, lines 21-39, col. 5, lines 46-48 and col. 6, lines 31-40). Here, the Examiner has interpreted the electrodes of the reference as a probe of the present application.

Claims 2, 17 and 29-31 lack an inventive step under PCT Article 33(3) as being obvious over Eyuboglu et al. in view of Hoult et al. (U.S. 5,735,278).

Eyuboglu et al. teaches all of the features of the present invention except for explicitly disclosing that the polarizing magnetic field is varied to vary the response signals by movement of the magnet, where the magnet is a permanent magnet and the movement is caused by an air-filled cylinder and controlled by the electrical control system. In the same field of endeavor, Hoult et al. teaches that a magnetic field may be varied by movement of the magnet, where the movement is caused by a hydraulic cylinder system, controlled by an electrical control system (col. 3, lines 25-37, col. 4, lines 26-31 and col. 9, lines 24-37). Although Hoult et al. does not specifically disclose that the magnet is a permanent magnet, it is well-known in the art that a magnetic field may be generated by any of a permanent magnet, a superconducting magnet or a resistive magnet (see, e.g., Sekihara et al. (U.S. 4,625,171), col. 1, lines 42-44). It would have been obvious to one of ordinary skill in the art at the time of the invention to have moved the magnet in order to change the magnetic field without the need for movement of the volume being examined (see for motivation Hoult et al. at col. 2, lines 38-44).

Supplemental Box

Claims 4, 9, 19 and 38 lack an inventive step under PCT Article 33(3) as being obvious over Eyuboglu et al. in view of Maudsley (U.S. 4,689,567).

Eyuboglu et al. teaches all of the features of the present invention except for expressly disclosing that the RF pulses produce MR free induction decay (FID) signals, which are detected and utilized in characterizing the tissue, and that the detected MR signals are analyzed for spin density, longitudinal relaxation time or transverse relaxation time. In the same field of endeavor, Maudsley teaches an MR system in which the RF pulses produce FID signals that are used to produce an image of the examined volume and where the response signals are analyzed to determine the transverse relaxation time of the volume (col. 1, lines 62-68, col. 2, lines 1-3 and col. 5, lines 55-62). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the techniques of Maudsley in the method of Eyuboglu et al. in order to increase the contrast of the results (see Maudsley at col. 1, lines 65-68).

Claims 7, 10, 15, and 36 lack an inventive step under PCT Article 33(3) as being obvious over Eyuboglu et al. in view of Littrup et al. (U.S.No. 2001/0051774).

Eyuboglu et al. teaches all of the features of the present invention except for expressly disclosing that the detected response signals are collected and analyzed for predetermined parameters characterizing the substance type and comparing the predetermined parameters with corresponding parameters of known substance types to produce a best match, that the parameters are modeled into a set and classified according to the known substance types and that a determination of whether the substance volume is cancerous or non-cancerous is made. In the same field of endeavor, Littrup et al. teaches a system using electrical impedance analysis, and may also include magnetic resonance imaging, where tissue types are analyzed and characterized according to a set of parameters, those parameters are modeled into a representation of the tissue type, compared to reference tissue types and where the system is used to determine the presence of cancer in the tissue (para. 4, lines 7-10 and para. 57, lines 1-30). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the methods of Littrup et al. in the system of Eyuboglu et al. in order to provide a safe, reliable and low-cost analysis of tissue pathologies (see for motivation Littrup et al. at para. 4, lines 4-7).

Claims 8 and 37 lack an inventive step under PCT Article 33(3) as being obvious over Eyuboglu et al. in view of Van Der Meulen et al. (U.S. 5,758,646).

Eyuboglu et al. teaches all of the features of the present invention except for expressly disclosing that the sequence of pulses has some pulses optimized for the electrical impedance responses and some for the magnetic resonance responses. In the same field of endeavor, Van Der Meulen et al. teaches a system where different RF pulses within a sequence are optimized according to the parameters of the response that they intend to target (col. 2, lines 6-16 and 25-34). It would have been obvious to one of ordinary skill in the art at the time of the invention to have optimized the RF pulses of Eyuboglu et al. in order to reduce the number of sequences from which an operator must select and to adapt the sequences to the particular response sought (see for motivation Van Der Meulen et al., abstract).

Claims 13 lack an inventive step under PCT Article 33(3) as being obvious over Eyuboglu et al. in view of Crooks (U.S. 5,442,290).

Eyuboglu et al. teaches all of the features of the present invention except for expressly disclosing that the magnetic resonance signals are electron magnetic resonance signals. In the same field of endeavor, Crooks teaches that a patient imaging volume may be monitored by an electron magnetic resonance detector (col. 4, lines 61-68 and col. 5, lines 1-3). It would have been obvious to one of ordinary skill in the art at the time of the invention that electron magnetic resonance signals could have been used instead of nuclear magnetic resonance signals because each is a suitable method of providing an image of a substance volume.

Claims 5, 6, 12, 14, 20-28, 32-35, and 47 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest the transmission line features and tissue analysis system as described.

Claims 1-38 and 47 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

---------- NEW CITATIONS ----------

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WHAT IS CLAIMED IS:

1. A method of examining a substance volume to characterize its type, comprising:

applying locally a polarizing magnetic field through the examined substance volume:

applying RF pulses locally to said examined substance volume from one side of the examined substance such as to invoke reflected electrical response signals corresponding to the electrical impedance (EI) of the examined substance volume, and magnetic resonance (MR) response signals corresponding to the MR properties of the examined substance volume;

detecting locally said EI and MR response signals; and

utilizing said detected response signals for characterizing the type of substance in the examined substance volume.

2. The method according to Claim 1, wherein said RF pulses are applied locally via a transmission line in contact with said one side of the examined substance.

3. The method according to Claim 1, wherein said RF pulses are applied locally via a first transmission line which is brought into contact with one side of the examined substance, while a second transmission line is brought into contact with another side of the examined substance, said RF pulses from said first transmission line being transmitted through said examined substance volume, detected by said second transmission line, and utilized in characterizing the examined substance volume type.

4. A method of examining a substance volume to characterize its type, comprising:

applying locally a polarizing magnetic field through the examined substance volume:

applying RF pulses locally, from a first side of the examined substance, such as to invoke electrical response signals corresponding to the electrical impedance (EI) of the examined substance volume, and magnetic resonance (MR) response signals

corresponding to the MR properties of the examined substance volume, said response signals being transmitted through said examined substance volume;

detecting locally, at a second side of the examined substance, said EI and MR response signals; and

utilizing said detected response signals for characterizing the type of substance in the examined substance volume.

5. The method according to Claim 1 or 4, wherein said polarizing magnetic field is varied such as to vary the EI response signals and the MR response signals invoked from the examined substance volume, said variations in the response signals also being detected and utilized in characterizing the examined substance volume type.

6. The method according to Claim 1 or 4, wherein said detected EI response signals invoked by the RF pulses are processed to calculate the effective electrical impedance of the examined substance volume, which calculated electrical impedance is utilized in characterizing the examined substance volume type.

7. The method according to Claim 1 or 4, wherein said RF pulses invoke MR free induction decay (FID) signals, corresponding to the echos from excited spins in the examined substance volume when returning to equilibrium, which FID signals are detected and utilized in characterizing the examined substance volume type.

8. The method according to Claim 4, wherein said RF pulses are applied locally via a transmission line in contact with said first side of the examined substance, said RF pulses invoking reflected pulses which are detected and utilized in characterizing the examined substance volume type.

9. The method according to Claim 4, wherein said RF pulses are applied locally via a first transmission line which is brought into contact with said first side of the examined substance, while a second transmission line is brought into contact with said second side of the examined substance so as to detect said transmitted response signals.

10. The method according to Claim 1 or 4, wherein said detected response signals are utilized to characterize the examined substance volume type by:

analyzing said detected response signals for predetermined parameters characterizing the examined substance volume type;

and comparing said predetermined parameters with corresponding parameters of known substance types to produce a best match.

11. The method according to Claim 1 or 4, wherein said RF pulses are applied as a sequence of pulses in which some pulses are optimized for EI measurements, and others are optimized for MR measurements.

12. The method according to Claim 1 or 4, wherein said detected MR response signals are analyzed for spin density, longitudinal relaxation time (T1), and/or transverse relaxation time (T2) of the examined substance volume.

13. The method according to Claim 1 or 4, wherein said detecting of the EI and MR response signals includes:

collecting the EI response signals and the MR response signals;

analyzing said collected response signals for predetermined parameters characterizing the volume substance volume type;

modeling the signal parameters into a set of parameters; and

classifying said set of parameters according to known parameter sets of known substance types.

14. The method according to Claim 1 or 4, wherein said invoked and detected magnetic resonance (MR) response signals are nuclear magnetic resonance (NMR) response signals.

15. The method according to Claim 14, wherein said NMR response signals are enhanced by the prior injection of a contrast agent.

16. The method according to Claim 1 or 4, wherein said invoked and detected magnetic resonance (MR) response signals are electron magnetic resonance (EMR) response signals.

17. The method according to Claim 16, wherein said EMR response signals are enhanced by the prior injection of a contrast agent.

18. The method according to Claim 1 or 4, wherein said examined substance volume is tissue examined to characterize it as cancerous or non-cancerous tissue.

19. Apparatus for examining a substance volume to characterize its type, comprising:

means for applying locally a polarizing magnetic field through the examined substance volume;

a probe having a transmission line capable of applying and locally detecting RF pulses;

and an electrical control and processing system for:

(a) applying RF pulses locally via said transmission line to said examined substance volume such as to invoke electrical impedance (EI) response signals corresponding to the electrical impedance of the examined substance volume, and magnetic resonance (MR) response signals corresponding to the MR properties of the examined substance volume;

(b) detecting locally said EI and MR response signals via said transmission line; and

(c) utilizing said detected response signals for characterizing the examined substance volume type.

20. The apparatus according to Claim 19, wherein said transmission line serves as both a transmitter of said RF pulses and a receiver of the reflected pulses.

21. The apparatus according to Claim 19, wherein said transmission line ended at one end by: an open end, a dipole, a V-shaped antenna, a conical antenna, a

surface coil or a single-sided leaky end; said electrical control and processing system applying said RF pulses via said transmission line, such as invoke reflected pulses from said examined substance volume, said reflected pulses being detected and utilized in characterizing the examined substance volume type.

22. The apparatus according to Claim 21, wherein said a transmission line which is ended at said one end by an open cavity.

23. The apparatus according to Claim 21, wherein said one end of the transmission line is electrically connected to a tuning circuit permitting the impedance of said one end to be varied and thereby to vary the reflectivity of the transmission line.

24. The apparatus according to Claim 23, wherein said tuning circuit also permits the strength of the magnetic field generated by the RF pulses to be varied.

25. The apparatus according to Claim 21, wherein said probe further comprises at least one coil at said one end of the transmission line, said coil being oriented orthogonally to the transmission line axis so as to detect MR signals in the direction of the transmission line axis.

26. The apparatus according to Claim 21, wherein said one end of the transmission line includes:

an inner conductive strip extending parallel to the longitudinal axis of the transmission line, and a pair of outer conductive strips, electrically connected to each other, extending parallel to, and on opposite sides of, said inner conductive strip, and separated therefrom by insulation;

a first RF coil located between said inner conductive strip and one of said outer conductive strips and extending perpendicularly to the longitudinal axis of the transmission line;

and a second RF coil located between said inner conductive strip and the other of said outer conductive strips and extending perpendicularly to the longitudinal axis of the transmission line.

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27. The apparatus according to Claim 21, wherein said one end of the transmission line includes:

a first conductive strip extending parallel to the longitudinal axis of the transmission line;

a second conductive strip extending parallel to said first conductive strip and separated therefrom by insulation;

and an RF coil located between said first and second conductive strips and extending perpendicularly to the longitudinal axis of the transmission line.

28. The apparatus according to Claim 19, wherein said means for applying locally a polarizing magnetic field is controllable by said electrical control and processing system to vary the polarizing magnetic field through the examined substance volume with respect to amplitude and/or depth.

29. The apparatus according to Claim 28, wherein said means includes a permanent magnet movably mounted on said transmission line to vary the polarizing magnetic field through the examined substance volume with respect to amplitude and/or depth.

30. The apparatus according to Claim 29, wherein said permanent magnet is movably mounted by means of an air cylinder carried by said transmission line.

31. The apparatus according to Claim 19, wherein said means includes one or more electromagnetic coils movably mounted with respect to said transmission line to vary the polarizing magnetic field through the examined substance volume with respect to amplitude and/or depth.

32. The apparatus according to Claim 19, wherein said means includes one or more electromagnetic coils carried by said transmission line and controllable by said electrical control and processing system to vary the polarizing magnetic field through the examined substance volume with respect to amplitude and/or depth.

33. The apparatus according to Claim 19, wherein said means includes one or more electromagnetic coils surrounding a paramagnetic core carried by said transmission line and controllable by said electrical control and processing system to vary the polarizing magnetic field through the examined substance volume with respect to amplitude and/or depth.

34. Apparatus for examining a substance volume to characterize its type, comprising:

means for applying locally a polarizing magnetic field through the examined substance volume

a probe;

an electrical control and processing system for:

(a) applying RF pulses locally via said to said examined substance volume such as to invoke electrical impedance (EI) response signals corresponding to the electrical impedance of the examined substance volume, and magnetic resonance (MR) response signals corresponding to the MR properties of the examined substance volume;

(b) detecting locally said EI and MR response signals; and

(c) utilizing said detected response signals for characterizing the examined substance volume type and

a marking device for marking the examined substance according to its type as determined by said electrical control and processing system.

35. Apparatus for examining a substance volume to characterize its type, comprising:

means for applying locally a polarizing magnetic field through the examined substance volume

a probe including an array of sensors;

and an electrical control and processing system for:

(a) applying RF pulses locally via said to said examined substance volume such as to invoke electrical impedance (EI) response signals corresponding to the electrical impedance of the examined substance volume, and magnetic resonance

(MR) response signals corresponding to the MR properties of the examined substance volume;

(b) detecting locally said EI and MR response signals; and

(c) utilizing said detected response signals for characterizing the examined substance volume type.

36. Apparatus for examining a substance volume to characterize its type, comprising:

means for applying locally a polarizing magnetic field through the examined substance volume

a probe, combined with a catheter;

and an electrical control and processing system for:

(a) applying RF pulses locally via said to said examined substance volume such as to invoke electrical impedance (EI) response signals corresponding to the electrical impedance of the examined substance volume, and magnetic resonance (MR) response signals corresponding to the MR properties of the examined substance volume;

(b) detecting locally said EI and MR response signals; and

(c) utilizing said detected response signals for characterizing the examined substance volume type.

37. Apparatus for examining a substance volume to characterize its type, comprising:

means for applying locally a polarizing magnetic field through the examined substance volume

a probe, combined with a biopsy core needle;

and an electrical control and processing system for:

(a) applying RF pulses locally via said to said examined substance volume such as to invoke electrical impedance (EI) response signals corresponding to the electrical impedance of the examined substance volume, and magnetic resonance (MR) response signals corresponding to the MR properties of the examined substance volume;

(b) detecting locally said EI and MR response signals; and

(c) utilizing said detected response signals for characterizing the examined substance volume type.

38. Apparatus for examining a substance volume to characterize its type, comprising:

means for applying locally a polarizing magnetic field through the examined substance volume

a probe combined with a cutting tool;

and an electrical control and processing system for:

(a) applying RF pulses locally via said to said examined substance volume such as to invoke electrical impedance (EI) response signals corresponding to the electrical impedance of the examined substance volume, and magnetic resonance (MR) response signals corresponding to the MR properties of the examined substance volume;

(b) detecting locally said EI and MR response signals; and

(c) utilizing said detected response signals for characterizing the examined substance volume type.

39. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said electrical control and processing system also: controls said means to vary the polarizing magnetic field such as to vary the EI response signals and MR response signals invoked from the examined substance; detects said variations in the response signals; and utilizes said detected variations in the response signals in characterizing the examined substance volume type.

40. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said electrical control and processing system processes the detected EI response signals invoked by the RF pulses to calculate the effective electrical impedance of the examined substance volume, and utilizes said calculated electrical impedance in characterizing the examined substance volume type.

41. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said electrical control and processing system applies RF pulses capable of invoking MR

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free induction decay (FID) signals, corresponding to the echos from excited spins in the examined substance volume when returning to equilibrium, detects said FID signals, and utilizes said detected FID signals in characterizing the examined substance volume type.

42. The apparatus according to Claim 34, 35, 36, 37 or 38, wherein said probe further comprises a transmission line for applying and locally detecting said RF pulses.

43. The apparatus according to Claim 42, wherein said transmission line serves as both a transmitter of said RF pulses and a receiver of the reflected pulses.

44. The apparatus according to Claim 34, 35, 36, 37 or 38, wherein said apparatus further comprises a transmission line which is ended at one end by: an open end, a dipole, a V-shaped antenna, a conical antenna, a surface coil, a single-sided leaky end; said electrical control and processing system applying said RF pulses via said transmission line, such as invoke reflected pulses from said examined substance volume, said reflected pulses being detected and utilized in characterizing the examined substance volume type.

45. The apparatus according to Claim 44, wherein said a transmission line is ended at said one end by an open cavity.

46. The apparatus according to Claim 44, wherein said one end of the transmission line is electrically connected to a tuning circuit permitting the impedance of said one end to be varied and thereby to vary the reflectivity of the transmission line.

47. The apparatus according to Claim 24, wherein said tuning circuit also permits the strength of the magnetic field generated by the RF pulses to be varied.

48. The apparatus according to Claim 44, wherein said probe further comprises at least one coil at said one end of the transmission line, said coil being

oriented orthogonally to the transmission line axis so as to detect MR signals in the direction of the transmission line axis.

49. The apparatus according to Claim 44, wherein said one end of the transmission line includes:

an inner conductive strip extending parallel to the longitudinal axis of the transmission line, and a pair of outer conductive strips, electrically connected to each other, extending parallel to, and on opposite sides of, said inner conductive strip, and separated therefrom by insulation;

a first RF coil located between said inner conductive strip and one of said outer conductive strips and extending perpendicularly to the longitudinal axis of the transmission line;

and a second RF coil located between said inner conductive strip and the other of said outer conductive strips and extending perpendicularly to the longitudinal axis of the transmission line.

50. The apparatus according to Claim 44, wherein said one end of the transmission line includes:

a first conductive strip extending parallel to the longitudinal axis of the transmission line;

a second conductive strip extending parallel to said first conductive strip and separated therefrom by insulation;

and an RF coil located between said first and second conductive strips and extending perpendicularly to the longitudinal axis of the transmission line.

51. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said means for applying locally a polarizing magnetic field is controllable by said electrical control and processing system to vary the polarizing magnetic field through the examined substance volume with respect to amplitude and/or depth.

52. The apparatus according to Claim 42, wherein said means includes a permanent magnet movably mounted on said transmission line to vary the polarizing

magnetic field through the examined substance volume with respect to amplitude and/or depth.

53. The apparatus according to Claim 52, wherein said permanent magnet is movably mounted by means of an air cylinder carried by said transmission line.

54. The apparatus according to Claim 42, wherein said means includes one or more electromagnetic coils movably mounted with respect to said transmission line to vary the polarizing magnetic field through the examined substance volume with respect to amplitude and/or depth.

55. The apparatus according to Claim 42, wherein said means includes one or more electromagnetic coils carried by said transmission line and controllable by said electrical control and processing system to vary the polarizing magnetic field through the examined substance volume with respect to amplitude and/or depth.

56. The apparatus according to Claim 42, wherein said means includes one or more electromagnetic coils surrounding a paramagnetic core carried by said transmission line and controllable by said electrical control and processing system to vary the polarizing magnetic field through the examined substance volume with respect to amplitude and/or depth.

57. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said apparatus further comprises:

first and second transmission lines to be brought into contact with different sides of the examined substance such that the RF pulses transmitted from one of said transmission lines are transmitted through said examined substance volume and are detected by the other of said transmission lines;

said electrical control and processing system utilizing said detected RF pulses in characterizing the examined substance volume type.

58. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said electrical control and processing system utilizes said detected response signals to characterize the examined substance volume type by:

analyzing said detected response signals for predetermined parameters characterizing the examined substance volume type;

and comparing said predetermined parameters with corresponding parameters of known substance types to produce a best match.

59. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said electrical control and processing system applies said RF pulses as a sequence of pulses in which some pulses are optimized for EI measurements, and others are optimized for MR measurements.

60. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said electrical control and processing system analyzes the detected MR response signals for spin density, longitudinal relaxation time (T1), and/or transverse relaxation time (T2) of the examined substance volume.

61. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said electrical control and processing system detects and processes said EI and MR response signals by:

(One) collecting the EI response signals and the MR response signals;

(Two) analyzing said collected response signals for predetermined parameters characterizing the examined substance volume type;

(Three) modeling the signal parameters into a set of parameters; and

(Four) classifying said set of parameters according to known parameter sets of known substance types.

62. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said electrical control and processing system utilizes the detected EI and MR response signals to characterize the examined tissue volume as cancerous or non-cancerous.

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63. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said electrical control and processing system further includes an indicator for indicating the type of the examined substance volume as determined by said electrical control and processing system.

64. The apparatus according to Claim 19, 35, 36, 37 or 38, wherein the apparatus further comprises a marking device for marking the examined substance according to its type as determined by said electrical control and processing system.

65. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said probe further includes a current sensor for sensing the current passing through the examined substance volume.

66. The apparatus according to Claim 19, 34, 36, 37 or 38, wherein said probe includes an array of sensors.

67. The apparatus according to Claim 19, 34, 35, 37 or 38, wherein said probe is combined with a catheter.

68. The apparatus according to Claim 19, 34, 35, 36 or 38, wherein said probe is combined with a biopsy core needle.

69. The apparatus according to Claim 19, 34, 35, 36 or 37, wherein said probe is combined with a cutting tool.

70. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said invoked and detected magnetic resonance (MR) response signals are nuclear magnetic resonance (NMR) response signals.

71. The apparatus according to Claim 19, 34, 35, 36, 37 or 38, wherein said invoked and detected magnetic resonance (MR) response signals are electron magnetic resonance (EMR) response signals.